PATENT ABSTRACTS OF JAPAN

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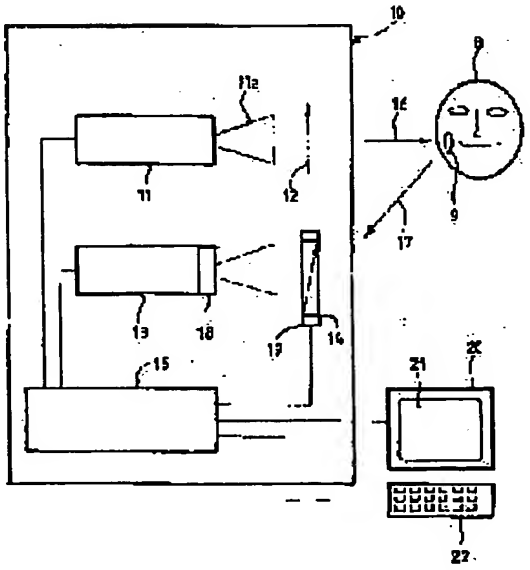
(54) DEVICE AND METHOD FOR INSPECTING SURFACE

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a method and device for inspecting surface which are used for inspecting a surface, for example, the skin of a human being.
SOLUTION: The device which is designed to inspect the surface (9) is provide with an ellipsometer element or photodetector (14) which is positioned on the route of a light beam (17) reflected by the surface (9), a digital image pickup means (13) which is positioned on the downstream side of the photodetector (14) on the route of the light beam (17), and a processing unit (15) which can calculate brightness and light intensity from a plurality of picture elements of at least one image.



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* NOTICES *

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CLAIMS

[Claim(s)]
[Claim 1] The polarization analysis component or analyzer (14) which is equipment designed so that a front face (9) might be inspected, and has been arranged in the path of the light beam (17) reflected on said front face, The digital image image pick-up means arranged in the path of the beam reflected in the downstream of an analyzer by said front face (13), Equipment characterized by having with the processing unit (15) which can calculate two or more brightness and reinforcement of a part of said front face from the pixel of at least two images of said front face.
[Claim 2] Equipment according to claim 1 characterized by having the source of polarization which can emit the beam (16) which carries out incidence to said front face which should be inspected.
[Claim 3] The light which came out from said source of polarization is equipment according to claim 2 characterized by being isotropy substantially.
[Claim 4] The light which came out from said source of polarization is equipment according to claim 2 or 3 characterized by the substantially white thing.
[Claim 5] The spectrum of the light which came out from said source of polarization is equipment according to claim 2 or 3 characterized by the solar spectrum and the substantially same thing.
[Claim 6] It is equipment any or given in 1 among claims 1-5 which an analyzer has a means to transmit a means to transmit rectangular polarization, and parallel polarization, and are characterized by said transmission means being in the condition of working by turns.
[Claim 7] An analyzer is equipment according to claim 6 characterized by being the thing of a rotating type.
[Claim 8] An analyzer is equipment according to claim 6 characterized by having the electric change means.
[Claim 9] The approach characterized by being the surface remote inspection approach, analyzing the polarization of a light beam reflected on said front face, picturizing the digital image of specific polarization of said reflective beam, and calculating two or more brightness and reinforcement of a part of said front face from the pixel of at least two images of said front face.
[Claim 10] Said front face is an approach according to claim 9 characterized by not being even.
[Claim 11] The approach according to claim 9 or 10 characterized by picturizing a monochromatic digital image.
[Claim 12] The approach according to claim 9 or 10 characterized by picturizing a multicolor digital image.
[Claim 13] The computer program which has a program code means to perform the phase of the approach of any or given in 1, among claims 9-12, at the time of the activation on a computer.
[Claim 14] The storage in which reading [equipment / which is memorized and reads any or a program code means by which the phase of the approach of a publication can be performed to 1, among claims 9-12 at the time of the activation on a computer] is possible.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to a property especially the skin or the surface equipment designed so that the brightness (brightness) of all keratin nature front faces could generally be evaluated, and a surface approach.
[0002]
[Description of the Prior Art] This equipment is a thing of a format which has the light source dispatched to the front face which should be inspected, a photodetector means sensitive to the light reflected on the front face, a means to measure the specular reflection and diffuse reflection from a front face, and a means to ask for brightness from the measurement result of specular reflection and diffuse reflection. The France country patent application public presentation No. 2,650,890 specification can be mentioned about this technique. According to the place which conducted inspection shows, this equipment brings about the result for which satisfaction goes, or sensibility and its discriminative power are comparatively low.
[0003] The equipment with which the Europe patent No. 475,803 specification was also designed so that a front face might be inspected is shown. This equipment It has the light source which can emit the beam which carries out incidence to the front face which should be inspected, the means which consists of a polarizer, and at least one analyzer. This analyzer The direction of a polarizer and the direction of an analyzer are mutually established in the parallel or photodetector means sensitive to the light further reflected on the front face by arranging an analyzer in the path of a reflective beam by being able to measure reflection in the condition of having made it the right angle, and arranging a polarizer between the light source and a front face. The light source has directivity, the incident beam which polarized hits the front face which should be inspected in whenever [0 degree - 90 degrees (0 degree and 90 degrees are not included) angle-of-incidence], and the polarization direction of an incident beam is perpendicular to an incidence flat surface. This equipment is constituted so that reflection may be measured along at least two mutually different reflective directions, and one of the reflective directions is substantially related to the direction of incidence in the symmetry about a surface normal. The difference acquired by this equipment's having a means by which reflection of parallel polarization and the analysis direction and reflection of perpendicular polarization and the analysis direction are distinguishable, about each reflective direction, and doing in this way serves as the so-called scale of specular reflection brightness, and a scale of the so-called diffuse reflection brightness.
[0004] Although this equipment functions normally, a unit front face or one inspection at the time of a certain specification is enabled. The purpose of this invention is to offer the data of the brightness about all surface parts in the time of a certain specification. The purpose of this invention is to offer advanced surface-analysis equipment.
[0005]
[Means for Solving the Problem] according to one description of this invention , the equipment designed so that a front face may inspect have with the processing unit which can calculate two or more surface brightness and reinforcement of a part from the pixel of the polarization analysis component or the analyzer arrange in the path of the light beam reflected on this front face , the digital image image pick-up means which have be arrange in the path of a beam in_which of it be reflected in the downstream of an analyzer by the above-mentioned front face , and at least two images of the above-mentioned front face . Inspection can be carried out in the place from which a certain distance was kept from the skin. In this way, fear of modification of the property that measurement is desired disappears. Two images mentioned above will be picturized about various polarization conditions.
[0006] Preferably, this equipment has the source of polarization which can emit the beam which carries out incidence to the front face which should be inspected. Preferably, the light which came out from the source of polarization is isotropy substantially. The light which came out from the source of polarization with 1 operation gestalt of this invention is substantially white. The spectrum of the light which came out from the source of polarization with 1 operation gestalt of this invention is substantially [as a solar spectrum] the same. With 1 operation gestalt of this invention, an analyzer will have a means to transmit a means to transmit rectangular polarization, and parallel polarization, and these transmission means will be in an active state by turns. With 1 operation gestalt of this invention, an analyzer is the thing of a rotating type. With another operation gestalt of this invention, the analyzer has the electric change means. As for a means to picturize a digital image, it is good that it is sensitive to a color. Advantageously, a processing unit has a microprocessor, a storage means, and the software memorized in the storage means.
[0007] This invention is the surface remote inspection approach, analyzes the polarization of a light beam reflected on this front face, picturizes the digital image of specific polarization of said reflective beam, and relates to the approach characterized by calculating two or more brightness and reinforcement of a part of the above-mentioned front face from the pixel of at least two images of the above-mentioned front face again. With 1 operation gestalt of this invention, the above-mentioned front face is not even. A monochromatic digital image is picturized with 1 operation gestalt of this invention. A multicolor digital image is picturized with 1 operation gestalt of this invention. This invention has a program code means to perform the disposition phase of the above-mentioned equipment again, at the time of the activation on a computer.
[0008] This invention is memorized and offers the storage which can be read again with the reader of a program code means by which

the disposition phase of the above-mentioned equipment can be performed, at the time of the activation on a computer. In this specification, the "point" or the "part" has pointed out the unit part of the front face of the dimension equivalent to 1 pixel of the image obtained by means to picturize an image to be examined. If it puts in another way, it will illuminate the good front face which should be inspected that they are a part of a part of people's pawl or pawl, face, or face. Lighting is performed by the light source or two or more light sources so that it may become isotropy as much as possible. The light which came out of the lighting means polarizes for example, with a fixed polarizer. The polarization of light reflected on the front face which should be inspected is analyzed, it dissociates and the part of the light where polarization is saved, and the part of the light from which polarization changed are carried out like the whole surface **** lever which should be inspected.

[0009] A digital image is picturized by the downstream of an analyzer for example, with a matrix camera. The purpose is in calculating the degree of polarization of the pixel of each image. From now on, the information about the brightness of an image will be reasoned by digital processing. At least two images [three] are picturized especially preferably about the analyzer and the front face which is not flat under rotation for this purpose. It is carried out without conducting inspection by non-contact. Fear of generating of the inaccuracy relevant to the concave of the front face resulting from that the purpose increases the amenity of those by whom one front face is inspected, and contact, or mutual arrangement of a convex configuration, or an error is abolished, It is in abolishing a possibility of changing brightness, therefore abolishing fear of generating of a measurement error especially about the front face where the treatment product the makeup which is in case surface part blanket-like voice changes by contact, dyeing, or care type is applied beforehand. The contents and other advantages of this invention will become clear if the detailed explanation about some operation gestalten shown in the attached drawing as a non-limiting example is read.

[0010]

[Embodiment of the Invention] Drawing 1 shows the body 1 equipped with the front face 2 illuminated by light, and two incident rays 3 and 4 of light are shown. A beam of light 3 passes along a front face 2, and goes into a body 1 in accordance with a path 5, next it serves as a form of the diffuse reflection beam of light 6, and it comes out of it. It goes into a body, and is reflected by this inside, and this diffusion or "color" reflection is equivalent to the light again emitted to the method of outside. The property of a reflected ray 6 is decided by the body 1. An incident ray 4 is reflected on a front face 2 with the gestalt of a reflected ray 7. Reflection of this kind is called specular reflection and is also called brightness (brightness). The light resulting from bright loess has the specular reflection property of incident light. The gestalt of the brightness diagram of a reflected ray 7 is decided by granularity of a front face 2.

[0011] It is desirable people's face 8 and to inspect the front face 9 of the face 8 especially so that it may understand by drawing 2 . The test equipment 10 which has the light source 11, the fixed polarizer 12, the matrix camera 13, an analyzer 14, and the processing unit 15 is offered for this purpose. The light source 11 is arranged so that a front face 9 may be illuminated. The emitted light is isotropy as much as possible. Measurement is because it has become clear that it is in the case of being influenced of whenever [incident angle / of the beam of light which hit the front face 9]. In the case of which, it will be necessary for the light source 11 to reproduce a solar spectrum as strictly as possible, i.e., to emit the white light.

[0012] When it explains concretely, the light source 11 consists of the flash lamp equipped with the xenon or the fluorescence tubing type extended spectrum, a continuation lamp, or multicolor light emitting diode. The light source 11 has further optical-system 11a a reflector or a reflecting mirror, a mirror, an objective lens, an optical capacitor, and optical-fiber type, in order to dispatch light at an angle of predetermined [which matched the front face 9]. If the fixed polarizer 12 is put in another way in the path of the incident light beam 16 emitted by the light source 11, it will be arranged between the light source 11 and a front face 9. Light polarizes to the downstream of the fixed polarizer 12 in the propagation direction of the incident light beam 16. As for the matrix camera 13, it is good that it is a CCD type thing, and while the light source 11 is working, it is constituted so that the reflected light beam 17 which came out from the front face 9 may be received. The matrix camera 13 is good to have the objective lens 18 which can be adjusted.

[0013] If an analyzer 14 is put in another way in the path of the reflective beam 17, it will be arranged between a front face 9 and the matrix camera 13. Orientation of the analyzer 14 can be carried out about an axis parallel to the axis of the reflective beam 17 between at least two locations where only the include angle of 90 degrees shifted. If it does in this way, the part of the light beam 17 which carried out outgoing radiation by specular reflection, and the part which carried out outgoing radiation by diffuse reflection can be separated, and, on the other hand, an analyzer 14 will bring about the same polarization result as the fixed polarizer 12 between these two locations. When that is not right, a fixed output is obtained by digital processing performed later. An analyzer 14 may be a polarizer in which orientation is possible, and this is advantageously equipped with the motor 19 which can be made to rotate this. In order to also hang down exact polarization, if a motor 19 is possible, it is good that it is a stepping motor type thing with high resolution.

[0014] The light source 11, a camera 13, and the motor 19 of the polarizer 14 in which orientation is possible are things of a format which it connects with the processing unit 15, and this processing unit 15 is memorized in at least one storage, at least one microprocessor, and storage, and have at least one control program which can be performed by 1 or two or more microprocessors. If the processing unit 15 is an image pick-up and request of an image with turning on and off of the light source 11, and a camera 13, it can adjust the suitable sense of an objective lens 18 and an analyzer 14. It is good to connect also with the monitor 20 equipped with the screen 21 in which it is possible, the equipment 9 in which the processing unit 15 was formed to the exterior of test equipment 10, for example, a front face, and the result of conducted inspection, i.e., the display of the image which can express the data processed by the processing unit 15. Moreover, it is good to connect the processing unit 15 to the keyboard 22 into which an operator enables it to input information or a command.

[0015] As for the polarizer in which orientation is possible, it is good that it is the thing of a form equipped with the mechanical orientation method equipped with two or more filters attached in the wheel driven by a "polarization rotator" or motor, and motor of an electro-optics-orientation method, for example, a display tech (Displaytech) company. As a modification, although the "beam splitter" of a polarization splitter cube (Oriel), for example, Oli El, can also be offered, two measurement cameras need to be used for this. Preferably, analyzers 14 are the electrooptical systems which can synchronize by the external channel which changed on real time and was connected to the control unit 15. When the analyzer is arranged in front of the matrix camera 13, the brightness which is the component of the light by which specular reflection was carried out on the front face 9 with the analyzer 14, and the color which is the

component of the light by which the backscattering was carried out in the front face 9 can be separated mutually. When there is an analyzer 14 in the same polarization direction as the incident light beam 16, a camera 13 takes up the light reflected by the front face 9 with the one half of a non-polarized component. When an analyzer 14 is in the incident light beam 16 in the right-angled polarization direction, a camera 13 takes up only the one half of a non-polarized component. The processing unit 15 performs algebraic multiplication actuation, in order to obtain a part for Mitsunari related with algebraic subtraction actuation and a color in order to obtain a part for Mitsunari related with brightness.

[0016] In order to acquire a good precision preferably, a sufficient number of images are collected per location of the arbitration of an analyzer 14. By the Fourier analysis of the measurement signal performed by the processing unit 15, while calculating the degree of polarization of the reflected light beam 17, a brightness component can be extracted together with the color component of a front face 9 from now on.

[0017] A reflected light beam can be made to focus on the matrix of a photosensitive component, for example, a CCD cel, by whenever [a certain solid angle] with the objective lens 18 of a camera 13. Lessons is taken from each location of an analyzer 14, and an image is collected through the image collection board relevant to the processing unit 15 or a camera 13, for example, the "IC-PCI" board of a imaging technology (Imaging Technology) company. Images are collected, when it is in a fixed position after an analyzer's rotating. Collection of two images, parallel polarization and rectangular polarization, is performed by hundreds mses. The matrix of a CCD cel performs the function of a radiometer. When the spectral density of brightness and the spectral density of the color about a backscattering component are the objects of an interest, it is good to use a spectrometer, the spectral distribution, for example, the specular reflection component, of the reflected light beam 17. The function of a radiometer and the function of a spectrometer can be doubled in the same equipment, for example, spectroradiometer, and can be given.

[0018] Drawing 3 shows the curve of the pixel reinforcement taken to the Y-axis as a function of the include angle of the analyzer taken to the X-axis. Thus, while polarization of the radiation with which it is equivalent to a color when the front face which should be inspected is illuminated by the light beam of a polarization condition is canceled, the radiation equivalent to brightness is still a polarization condition. By rotation of an analyzer, the contribution of the brightness of the place of each point of an image and the contribution of a color can be searched for. If an analyzer is rotated, the reinforcement of the pixel of the place of a given part will change in the state of a sine wave substantially. If it reflects from a front face to be examined, the sense of polarization of the reflective part of the light beam equivalent to brightness will rotate only the amount relevant to the include angle of an incident beam and the normal of the front face inspected in this part to make.

[0019] If the front face which should be inspected is even, polarization angle of rotation is the same about each point. In this case, in order to ask for the part resulting from the color which can be set despite each point of an image, and the part of brightness, it is only sufficient to obtain two images at two mutually different include angles of an analyzer, and the maximum of the curve of drawing 3 R> 3 and the image of another side are equivalent to that minimum value for one image. It can ask for the angular position of an analyzer easily automatically. These are because it is equivalent to a great portion of the minimum value and maximum of an image. If the front face which should be inspected is not flat, it is required for a phase shift to appear on each point of an image, and to use at least three mutually different locations of an analyzer. The reinforcement of the place of each point can be expressed like a degree type.

[0020] I=Ia +Ib cos (2theta)

theta is an include angle between an analyzer and a vertical line, and Ia here. The average of Signal I, Ib It is the one half of the difference of the maximum of Signal I, and the minimum value. When using three locations in which only 45 degrees of fixed include-angle spacing were kept, for example, the following things are obtained in the place of each point of an image. The various phases of the approach of inspecting a front face 9 are shown in drawing 4 .

[0021]

I0=Ia +Ibcos (2theta0)

I45=Ia+Ibcos (2 (theta0+pi/4))

= Ia+Ibcos(2theta0+pi/2) =Ia-Ibsin (2theta0)

I90=Ia+Ibcos (2 (theta0+pi/2))

= Ia+Ibcos(2theta0+pi) =Ia-Ibcos (2theta0)

It follows. Ia= (I0+I90)/2 Ib= [(I90-Ia) 2+(I45-Ia) 2] 1/2 =1/2[(I90-I0) 2+(I45-I0-I90)2] 1/2 however Ibrightness=2Ib, and Icolour=2 (Ia-Ib)

It follows. Ibrightness= [(I90-I0) 2+(I45-I0-I90) 2] 1/2 Icolour=I0+I90-[(I90-I0) 2+(I45-I0-I90)2]1/2[0022] An operator or a user controls initiation of inspection in a phase 30 using a keyboard 22. In a phase 31, the processing unit 15 which received the initiation command starts starting sequence, and delivery and the light source 11 start emission of the incident light beam 16 to the light source 11. In a phase 32, a camera 13 picturizes an image, when the include angle of an analyzer 14 is 0 degree. In a phase 33, a camera 13 picturizes an image, when the include angle of an analyzer 14 is 45 degrees, and in a phase 34, a camera 13 picturizes an image, when the include angle of an analyzer 14 is 90 degrees. When it is thought that the front face 9 which should be inspected is even, an operator may exclude a phase 33 especially, when this is a very small front face. In a phase 35, the processing unit 15 will perform the numerical calculation which can obtain a brightness image and a color image, if the brightness component and color component in the reflected light beam 17 are separated and put in another way. In a phase 36, the result of processing is expressed as the gestalt of the gestalt which appears in the most suitable form, for example, a curve, a graph, a diagram, etc. on a screen 21. During operation of phases 35 and 36, in order to enable it to start inspection of another front face always, the analyzer 14 is designed so that it may return to the include angle of 0 degree.

[0023] With another operation gestalt of this invention, an analyzer performs continuation rotation and picturizes some images with a camera 13 during this continuation rotation. In the case of the given front face which should be inspected, as many images are picturized, the evaluation precision of brightness becomes higher so further. It takes that human being's eyes are more sensitive to the contrast of brightness and a color than brightness into consideration during operation of the processing phase 35 by the processing unit 15. If an example is given, it will be thought that the black of the brightness of given level is brighter than white when the level of

brightness is the same. Therefore, in one side, the processing unit 15 calculates brightness in comparison with a color in another side while performing count which can carry out the map of the brightness. Preferably, the information about the brightness in comparison with the most appropriate color will be displayed about the impression perceived by human being's eyes.

[0024] In this way, brightness and relative brightness, such as all types of front face especially a keratin nature front face, for example, hair, a lip, a pawl, and the skin, can be measured with surface-analysis equipment. The treatment product of the type of versatility [front face / of these versatility] beforehand, for example, hair and a product, dyeing, a makeup product, etc. may be applied. In a makeup, surface-analysis equipment can estimate whenever [mat / of the front face where the makeup was given, especially the skin].

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the schematic drawing of the reflective condition of two beams of light.
[Drawing 2] It is the schematic drawing of the equipment as 1 operation gestalt of this invention.
[Drawing 3] It is the graphical representation showing change of the reinforcement of the pixel as a function of the include angle of an analyzer.
[Drawing 4] It is the flow chart of the various phases of the inspection approach.
[Description of Notations]
8 Face
9 Front Face
10 Test Equipment
11 Light Source
12 Fixed Polarizer
13 Matrix Camera
14 Analyzer
15 Processing Unit
18 Objective Lens
19 Motor

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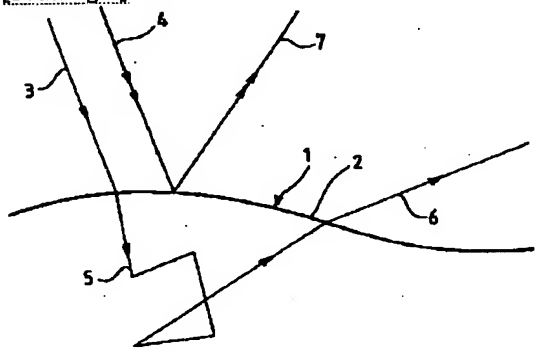
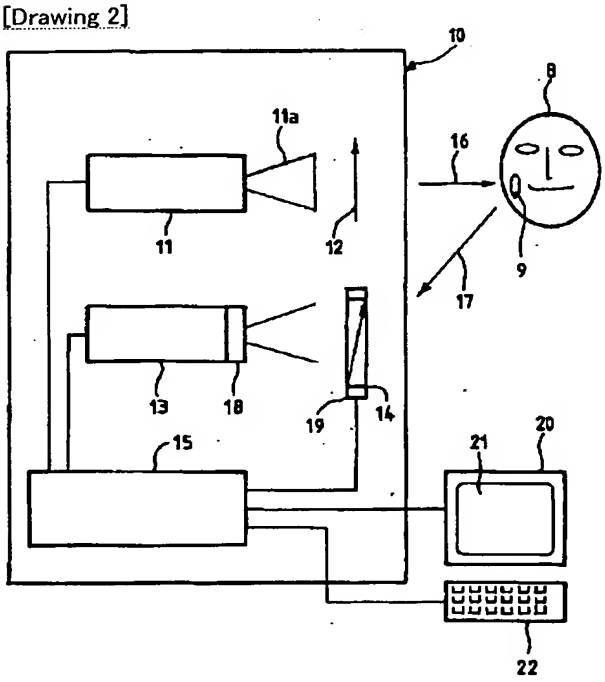
DRAWINGS

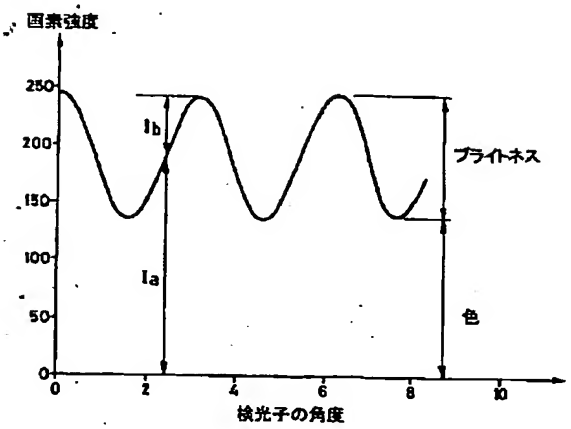
[Drawing 1]



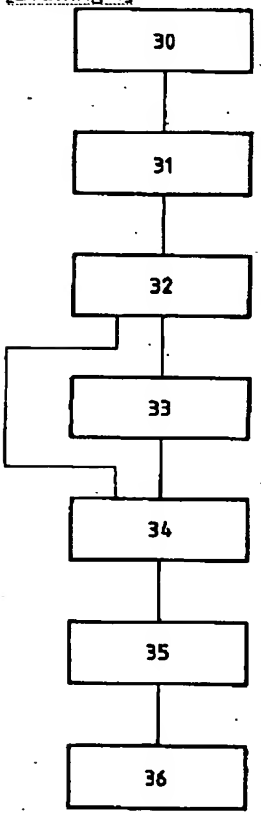
[Drawing 2]



[Drawing 3]



[Drawing 4]



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